MEMORANDUM

To: Working Group 3

From: Charles River Associates

Date: January 7, 2005

Subject: **UPDATED SPP RESULTS**

This memorandum expands upon the results that were summarized in the memorandum circulated to Working Group 3 on December 8^{th}. We are continuing to analyze the data and the findings reported below should be viewed as preliminary and subject to revision.

Please note that some of the results in this memo differ from those in the December 8^{th} memo. We are presenting these results for discussion at the Working Group 3 meeting on January 7. They are not intended to take the place of the final report that will be circulated for review in late January.

1. Summary

This memorandum addresses five questions:

- Do demand response impacts for the CPP-F rate differ between the summer of 2003 and 2004?
- Do demand response impacts differ between the warmer summer months of July, August and September (the inner summer) and the milder shoulder months of May, June and October (the outer summer)?
- Do demand response impacts stay the same, increase or decrease in the second and third days of a multi-day CPP event?
- What are the price elasticities for C&I customers in Track A of the CPP-V treatment in 2004?
- What are the price elasticities for C&I customers in Track C of the CPP-V treatment in 2004?

1a. Summary of Residential Results

- We have made two types of comparisons for CPP-F customers in Track A. The first involves customers who participated during the summer months in both 2003 and 2004. Based on this analysis, the difference in the elasticity of substitution on CPP days in 2003 and 2004 is not statistically significant but the daily price elasticity rises by a statistically significant amount in 2004. Peak-period and daily impacts on CPP days do not differ by a statistically significant amount across the two years. Off-peak impacts on CPP days were smaller in 2004 than in 2003.

- A second comparison involves all customers who were in the sample during the two years. The conclusions are the same as for the common-customer comparison except that both the off-peak and daily impacts on CPP days differ by statistically significant amounts.

- CPP impacts persist across the days in a multiple CPP event. This was tested through two different approaches and both confirmed the persistence hypothesis.

- Results for the Track A, CPP-V treatment reported in the qualitative memo circulated on December 8th should be ignored due to discrepancies between the dispatch calls sent to customers and the actual dispatch pattern for the enabling technology. The revised analysis will be presented in the final report.

1b. Summary of Commercial and Industrial Sector Results

- Preliminary results are currently available for the CPP-V rate for both Track A and Track customers for 2004. Separate results are presented for customers with peak demands below 20 kW (LT customers) and for those with demands between 20 and 200 kW (GT20 customers). The Track A sample was recruited from the general population while the Track C sample was drawn from a pre-existing Smart Thermostat pilot. All Track C customers have central air conditioning and smart thermostats. Most Track A customers have central air conditioning but only about 1/3 of the LT20 and about 60 percent of GT20 customers selected smart thermostats. During the experiment, for Track C customers, both control and treatment customers had their smart thermostats dispatched on CPP days. Thus, responsiveness on CPP days represents price response over and above the amount resulting from the technology. For Track A customers, responsiveness reflects both the impact of behavioral changes as well as technology for those customers who selected the enabling technology. As a result of the differences outlined above, comparisons between Track A and Track C customers should be made with carefully.

- For the LT20 Track A customer segment, the elasticity of substitution in 2004 equals –0.045 and is statistically significant. The daily price elasticity is highly insignificant.

The substitution elasticity increases with average daily use (ADU). Customers who choose a technology to go along with the CPP-V rate had a nominally higher elasticity but the difference was not statistically significant.

- For the GT20 Track A customer segment, the elasticity of substitution in 2004 equals –0.069 and is statistically significant. Once again, the daily price elasticity is statistically insignificant. Responsiveness did not vary with ADU within this customer segment, nor was the presence of enabling technology a statistically significant determinant of demand response.

- The estimated elasticity of substitution for the LT20 Track C customer segment for 2004 equals –0.055 and is statistically significant while the daily price elasticity is insignificant. The elasticity of substitution increases with average daily use (ADU).

- For the GT20 customer segment, the elasticity of substitution equals –0.063 and is also statistically significant. The elasticity falls as ADU increases. The daily price elasticity is not significant.

2. Methodology

This section summarizes some important differences between the analysis presented in the Summer 2003 report and the analytical approach that underlies the new results summarized in this memorandum. The results presented in the Summer 2003 report were based on data averaged over 15 day types and time periods and a fixed-effects model specification. Separate equations were estimated representing the ratio of energy use in the peak and off-peak periods (the substitution equation) and daily energy use. Each equation was estimated independently and separate models were developed for weekends and weekdays. For the CPP-F treatment, both the substitution and daily equations included a price term (the ratio of prices in the peak and off-peak period for the substitution equation and the daily average price for the daily equation), a weather term, a price-times-weather term, and a price-times-central air-conditioning-ownership term.

The new models contain the same variables as the previous approach, but use daily data instead of average daily data. The statistical challenges that were previously addressed using average data are now largely addressed using a data transformation known as first differences. Weekday and weekend data are pooled (while using binary variables to allow for differences across weekdays and weekends), and the substitution and daily equations are estimated simultaneously using Zellner's Seemingly Unrelated Regression (SUR) methodology, rather than independently.

This allows for more accurate estimation of standard errors for the two elasticities and for the load impact estimates.[1]

Importantly, when estimated using the same database, the new approach produces elasticity and impact estimates that are not statistically different from the estimates contained in the Summer 2003 report. The new approach greatly facilitates investigation of key issues such as whether or not impacts vary across multiple-CPP day events, whether there are statistically significant differences on weekdays and weekends, and the development of statistically valid standard errors of the elasticities and impacts.

3. Do Impacts Differ Between Summer 2003 and 2004?

This section compares the summer 2003 and 2004 estimates for the residential CPP-F treatment that was deployed in Track A of the pilot. Because the sample of both treatment and control customers has evolved over the course of the experiment, there are several ways to approach this question.

One approach is to examine whether or not the response has changed for customers that have participated in the experiment for both summers. This approach investigates whether demand response for the same group of customers increases (as they learn better how to respond to price signals), decreases (as the initial enthusiasm fades) or stays the same (reflecting a quick learning curve that doesn't degrade over time)? This question has been addressed using a pooled database containing information on energy use during the treatment period from both summers for all treatment and control customers that were in the sample during both summers.[2] This model was estimated using data for all relevant summer months in the two years. Since the pilot began placing customers on the CPP-F treatment in July of 2003, this created an imbalance in the data from the two years. To control for this, we introduced a binary variable for the outer summer months of October in 2003 and May and June in 2004. We then focused on comparing the results across the inner summer months of July, August and September for each summer.[3]

We used a binary variable representing the summer of 2004 interacted with all price and weather variables to assess whether or not the price elasticities vary across the two summers. If there were just a single price/year interaction term, the t-statistic for the interaction term could be used to answer the question of whether or not the elasticity of substitution or daily price elasticity

1 The new approach is documented further in the Analytical Issues memorandum dated November 2nd.

2 The database also contains pretreatment data for all customers, whenever it occurs.

3 The treatment period in the summer of 2003 for most customers covered the months of July through October. The estimating sample for the summer of 2004 covers the months of May through September (we did not receive October data in time to complete this analysis). Both summers had 12 CPP events.

differed across years. However, there are three terms that underlie the elasticity estimates (e.g., price, price times weather and price times a central air conditioning ownership variable). Thus, a standard error must be developed for the elasticity of substitution and for the 2004 differential that takes into account the standard errors of each price coefficient as well as the covariance across the coefficients in each equation and across the two equations in the demand system.

It should also be noted that the standard errors of the elasticities and the impacts vary with the mean values of the weather and air conditioning saturations that underlie them. Different weather averages will be used when estimating actual impacts for 2004 or for the average across the two summers.[4]

Table 1 contains some key background information. Row 1 reproduces the estimates from the Summer 2003 report, which were based on the earlier modeling approach involving 15 day types. Row 2 shows the results for 2003 based on the new modeling approach involving the use of daily observations and first differences. The elasticities and impacts are quite similar across rows 1 and 2, indicating the robustness of the estimates derived in the Summer 2003 report.[5] Row 3 shows the 2003 results when the estimating sample is constrained to the warmer months of July, August and September, i.e., the inner summer. The daily price elasticities are nearly identical in rows 2 and 3 but the elasticities of substitution and the impacts differ by slightly more than two standard deviations, with the values based on the hotter months being higher than when they are based on the entire summer period.

3a. Comparison Based on Common Customers

Table 2 contains estimates for the two elasticities for 2003 and 2004 based on a database that is restricted to customers that were in the experiment in both summers. The elasticity of substitution in 2003 from the pooled model is -0.090, with a t-statistic of –20.82. This value is very similar to the value in row 3 of Table 1, -0.087, which was obtained when the model was estimated on just the 2003 data. Table 2 also shows the differential value for each elasticity

[4] It should also be noted that, when estimating the standard errors, we have taken into account the fact that neither the impacts nor the elasticities are normally distributed -- they are at best approximately normal but this approximation is useful. We have taken this into account using the "delta method" for estimating standard errors, which can be applied to all the complex functions underlying the elasticities and impacts simultaneously. It is standard usage in statistics and provides a useful guide to the magnitudes of uncertainty.

[5] Please note the explanation in footnote 4 of Table 1 concerning why the impacts differ more than the elasticities.

between the two years. The difference in the elasticity of substitution is 0.004 and is not statistically significant, with a t-statistic of 0.64.[6]

The daily price elasticity in 2003 equals –0.035, with a t-statistic of –7.17 in 2003. The annual differential value equals –0.020 and has a t-statistic equal to –2.42, indicating that the 2003 and 2004 values are statistically different. The 2004 daily price elasticity is –0.054, with a t-statistic of –8.41.

Statewide impacts on peak, off-peak and daily energy use are presented in Table 3. Two impact measures are shown, one for the "average California customer" and one for the all zones impact. The average customer impact is developed using input values (e.g., weather, air conditioning saturations and starting energy use values by rate period) representing the average customer across all climate zones. The all-zone average uses input values pertinent to each climate zone and then computes a population-weighted average of the absolute impacts developed for each zone. It is only possible to compute standard errors and t-statistics for the average customer values because the impact formulas are non-linear. However, the all-zone values more accurately predict the statewide impacts. The standard error based on the average customer should be a close approximation to the standard error of the all-zone average and we recommend using the average customer standard error to develop confidence bands around estimates based on the "bottom-up," all-zone values.

The average customer impact on peak energy use in 2003 is –13.27 percent, with a standard error of 0.62 percent. The corresponding all zone impact in 2003 is –14.63 percent. The average customer impact in 2004 is –13.78 percent, with a standard error of 0.77 percent and the corresponding all-zone impact is –15.10. The 2003 and 2004 impacts are not statistically different from each other, since their differential of –0.62 percent has a large standard error of 1.08 percent, with an implied t-statistic of 0.57.

In 2003, the average customer impact for off peak energy use is +2.61 percent, with a standard error of 0.34 percent. The change in this impact between the two years is –1.41 percent, with a standard error of 0.54 percent. This has an implied t-statistic of –2.60, making the change statistically significant. The impact on daily energy use in 2003 is –2.09 percent, with a standard error of 0.29 percent. The change in the daily use impact between the two years is –1.17 percent with a standard error of 0.48 percent and an implied t-statistic of –2.44. Thus, the peak period impact for the CPP-F rate is statistically indistinguishable between the years 2003 and 2004 but the impacts during the off-peak period and daily use are statistically different.

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[6] All statistical test results are reported at the 5 percent level of significance. A t-statistic greater than 1.96 indicates statistical significance at the 95 percent confidence level.

In summary, when the comparison is based on the same group of customers, the reduction in peak-period energy use resulting from the CPP-F rate is essentially the same in 2003 and 2004. The increase in off-peak energy use (resulting from the lower off-peak prices) is actually less by a statistically significant amount in 2003 than it is in 2004. The impact on daily energy use is also greater by a statistically significant amount in 2004 than in 2003. Thus, there is no evidence from the two-year experiment that price responsiveness diminishes over time.

3b. Comparison Based on All Customers

The analysis summarized in Section 3a was conducted using a database of common customers. A second approach to examining the difference across the two summers is to develop elasticities and impacts for each summer based on the entire sample of customers that participated in each summer, rather than constraining the sample to customers that are common to both years. For the CPP-F rate, approximately 55 control customers and 73 treatment customers were added to the sample after October 31, 2003 as either replacement or new participants. These customers represent a turnover of about 14 percent for control customers and about 12 percent for treatment customers.

Table 4 contains the elasticities based on the all customer database. The elasticity of substitution in 2003 is –0.086, with a t-statistic of –20.47. The 2004 value is not statistically different from the 2003 value. The daily price elasticity is –0.032 in 2003, with a t-statistic of –6.80. The 2003 value is statistically different from 2004 value of –0.054. In general, these results are very similar to those based on the common customer database.

Table 5 contains the impact estimates for each year. The average customer impact on peak energy use in 2003 is –12.68 percent, with a standard error of 0.61 percent. The corresponding all zone impact in 2003 is –14.01 percent. The average customer impact in 2004 is –13.90 percent, with a standard error of 0.75 percent, based on the average customer approach and the all-zone value is –15.2. The two impacts do not differ statistically from each other, since their differential of –1.39 percent has a large standard error of 1.05 percent, with an implied t-statistic of –1.32.

In 2003, the average customer impact on off peak energy use is +2.56 percent, with a standard error of 0.33 percent. The change in this impact between the two years is –1.29 percent, with a standard error of 0.53 percent. This has an implied t-statistic of –2.43, indicating that the change between the years is statistically significant.

The impact on daily energy use in 2003 is –1.94 percent, with a standard error of 0.28 percent. The change in the daily use impact between the two years is –1.32 percent with a standard error of 0.47 percent and an implied t-statistic of –2.79. It also differs from the 2004 value. Thus, the peak period impact for the CPP-F rate is statistically indistinguishable between the years 2003 and 2004 but the impacts during the off-peak period and daily use are statistically different.

4. Intra-summer Differences

We next examine whether impacts differ between the relatively hot inner summer months of July, August and September and the milder outer summer months of May, June and October. The hypothesis is that the outer summer values will be less than the inner summer values because there impacts are driven to a large extent by modifications in air conditioning use and there is limited use of air conditioning in the outer summer period relative to the inner summer period. The intra-summer analysis imposes the same coefficients between the two years, in order to focus on a single issue. Later on, when examining the persistence of CPP impacts across multiple days, we relax this constraint and use a more general model specification.[7]

The model specification that is used to test for intra-summer differences allows for differences to exist in the daily price elasticity between weekdays and weekends and in the intercept term in the elasticity of substitution equation (to allow for different load shapes between weekends and weekdays). Since the weekends only feature an off-peak price, it is not possible to estimate a distinct weekend substitution elasticity. However, we do allow for a distinct weekend intercept term in the substitution equation.

The elasticities of substitution and daily price elasticities for the inner and outer summers for the four climate zones for each of the three day types are shown in Table 6. Associated standard errors and t-statistics are shown as well. The average weather conditions across the years 2003 and 2004 are used to calculate the mean estimates and standard errors. The weather values are specific to each day type and zone within each of the two summer seasons.

In the inner summer, on CPP days, the all-zone substitution elasticity is -.086, with a t-statistic of –26.0. The elasticity of substitution varies by +/- 50 percent relative to the mean across the four climate zones, with the lowest value (in absolute terms) of –0.043 occurring in the coolest zone 1 and the highest value of –0.127 occurring in the hottest zone 4.

As expected, the elasticities are smaller in the outer summer than in the inner summer. In the outer summer, the all-zone elasticity of substitution is –0.037, with a t-statistic of –6.29. There is significant variation in the elasticity of substitution across climate zones, rising from the coolest zone to the hottest zone. However, the zonal variation is not as marked as the variation in the inner summer, with the ratio of the high to low elasticity of substitution equal to 1.9 rather than 3.0 as was the case for the inner summer. This is due to the fact that central air conditioning plays a less dominant role in explaining customer price responsiveness in the outer summer

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[7] As seen below, there are significant differences in the elasticities between the inner and outer summer periods. This memo does not present an average value for the entire summer, but such a value will be included in the final report.

months, as evidenced by the large, positive coefficient on the air conditioning/price/outer summer interaction term in the demand model.[8]

The average daily price elasticity on CPP days in the inner summer across all-zones is –0.040, with a t-statistic of –10.52. There is very little variation in this value across climate zones, since the coefficient on the weather/price interaction term in the demand model is very small and is statistically insignificant and the coefficient on the air conditioning/price interaction term is also small (but significant). In the outer summer, the daily price elasticity is somewhat larger at –0.055, with a t-statistic of –6.84.

There is not much variation in the elasticities across CPP and non-CPP days since the weather coefficients on the price responsiveness terms are very small in size. For example, the all zone elasticity of substitution is –0.081 on non-CPP days compared to -0.086 on CPP days. Weekend daily price elasticities are generally higher than weekday daily price elasticities.

The associated impacts for the inner and outer summers are shown in Tables 7 and 8 respectively. The tables contain information on customer load shapes in the absence of the new pricing program, as measured by energy used by pricing period. This is labeled “starting value” in the tables and expressed in kWh/hr. The tables show the impact and standard errors expressed in both absolute terms and as a percent.

Table 7 shows that the impact on peak energy use on CPP days in the inner summer for all zones is 13.03 percent, with a standard error of 0.48 percent. Thus, a two-standard deviation band representing a 95 percent level of confidence can be defined from 12.07 percent to 13.99 percent.[9] As shown earlier with the elasticities, the impacts are lowest in the cooler zones and highest in the hotter zones.

On CPP days, for all zones, off-peak energy use rises by 2.06 percent, with a standard error of 0.26 percent. Finally, on CPP days, for all zones, daily energy use falls by –2.4 percent, with a standard error of 0.23 percent.

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8 The coefficient on the price/air conditioning saturation interaction term in the inner summer equals –0.09 with a t-statistic equal to –4.28. The coefficient on the price/air conditioning/outer summer interaction term equals 0.07, with a t-statistic equal to 6.49. That is, the influence of air conditioning on the elasticity of substitution is significantly less in the outer summer than in the inner summer.

9 As discussed in Section 3a, we believe the more accurate statewide impact is based on the population-weighted average of the zonal impacts, rather than average customer value presented in this paragraph. Averaging the 2003 and 2004 impacts from Tables 3 and 5 gives an average impact across the two years based on the all zone approach equal to –14.6. Applying the average customer standard errors from Table 7 to this zonal average impact, the confidence band on the statewide impact would range from –13.6 to –15.6.

Impacts are appreciably smaller on non-CPP days, reflecting the lower peak prices on these days. The all zones impact during the peak period is –4.15 percent, with a standard error of 0.18 percent. Weekend use rises by 2.08 percent, with a standard error of 0.22 percent.

Table 8 shows the impacts for the outer summer. These values reflect not only differences in the elasticities between the inner and outer summer, but also differences in the starting values. As seen, the impacts are lower in the outer summer compared with the inner summer, reflecting the similar pattern between the elasticities during the two summers. The drop in peak period enery use on CPP days for all zones is 8.11 percent, with a standard error of 0.88 percent. Off-peak energy use also shows a decline during the outer summer of 1.16 percent, with a standard error of 0.51 percent. Finally, daily energy use falls by –2.96 percent, with a standard error of 0.43 percent.

As in the inner summer, impacts are appreciably smaller on non-CPP days, reflecting the lower peak prices on these days. The all-zone impact during peak periods equals –2.20 percent, with a standard error of 0.38 percent. Weekend energy use rises by 1.63 percent, with a standard error of 0.38 percent.

5. Do Elasticities Vary Across Multiple-CPP Days?

In 2004, several multiple CPP-day events were conducted in order to examine whether people respond differently on the second and/or third days of a multi-day CPP event. Specifically, two three-day events and one two-day event were called. Thus, of the 12 CPP days called during the summer of 2004, there were a total of seven days that were either stand-alone days or the first day of a multi-day event, three days that were second days of a multi-day event and two days that were the third day of a multi-day event.

To test for differences across the CPP day types, binary variables representing each of these three CPP-day-types were developed and used as interaction terms with each of the price and weather terms in the basic model specification. We conducted two types of persistence tests. The first test involved the use of binary variables for the second and third CPP days. This test measures whether the second and third days differ from the average responsiveness across the first CPP day and non-CPP days. The test is carried out using a model that allows responses to differ between the two years and between the inner and outer summers, in addition to differing across the CPP day types.

The second test involved the use of binary variables for the first, second and third CPP days. It measures whether or not the deviations in each of the CPP days from all non-CPP days are statistically different from each other. This test is based on the chi-squared statistic. Each of these tests is discussed below.

5a. Persistence Test 1—2nd and 3rd Day Dummies

The results of the first persistence test, using second and third day binary variables, are reported in Tables 9, 10 and 11. Table 9 contains the elasticities and the following two tables contain the impacts. Results are reported by zone and also for the average customer. The first block of columns in Table 9 contain the substitution and daily elasticities for the summer of 2003. Since there were no multiple day events called in 2003, these elasticities measure CPP Day 1 behavior (which is assumed to be the same as the behavior on non-CPP days in this formulation). The second block of columns contain the corresponding Day 1 impacts for 2004. The third and fourth blocks contain the differentials between the Non-CPP/First-CPP-Day values and the values on the second and third days of 2004.

The first point to note is that, consistent with the earlier discussion in this memo, the elasticity of substitution on Day 1 for the average customer, -0.084, is constant across the two years, while the daily price elasticity rises from –0.034 to –0.055 in 2004. Focusing next on the differentials associated with the second and third CPP days, we find that only one of the four differentials is statistically significant at the average customer level, namely the differential corresponding to the elasticity of substitution on the second day, which has a t-statistic of –2.09. This indicates that the elasticity of substitution on the second day is statistically higher than on the first day for the average California customer. This difference in behavior appears to originate in zones 1 and 2 where the t-statistics on the differentials are both roughly –2.5. The daily price elasticity differential on the third day is also statistically significant in zones 1 and 2, and suggests a dampening of response. However, the average customer daily price elasticity differential on the third day, while numerically sizeable at 0.023, is not statistically significant.

Day 1 impacts are shown in Table 10. For the average customer, the impact on peak periods during CPP days rises from –12.51 percent to –13.54 percent between 2003 and 2004. The impact differentials for days 2 and 3, compared to day 1, are shown in Table 11. For the average customer, peak-period impacts on the second and third CPP days of a multi-day event are not statistically different from the Non-CPP/First-CPP-Day average. In zones 1 and 2, the impacts are larger on the second day by a statistically significant amount.

The impact differential on off-peak energy use for the average customer is positive and statistically significant on the second day, with a value of 1.49 percent. This impact differential is statistically significant in zones 1, 2 and 3 as well. It is also significant on the third day for zone 2.

The third day impact differentials on daily energy use are not statistically significant for the average customer on either the second or third day. However, they are significant in zones 1 and 2.

To summarize, the impact differentials for peak-period energy use on CPP days are not statistically significant for the average customer statewide on either the second or third day.

However they are significant in zones 1 and 2, and show an increase in impacts on these days compared with the average of non-CPP and first CPP days.

5b. Persistence Test 2—1st, 2nd and 3rd Day Dummies

The results of the second persistence test, which includes binary variables representing all three CPP day-types, are reported in Tables 12, 13 and 14. Table 12 contains elasticity estimates for non-CPP days during the Summer 2004 in the first block of columns. Differentials for the first, second and third days are shown in the next several blocks. To make the estimates comparable across the three day-types, all estimates are based on zone-specific central air conditioning saturation estimates and average weather conditions across all CPP days during the inner summer months for both years.

On non-CPP days (under average CPP weather conditions), the substitution elasticity for the average customer is –0.069 and the daily price elasticity is –0.074. Both are statistically significant. On Day 1, the substitution elasticity is significantly different and higher by –0.016. The daily elasticity is lower by 0.015 but not statistically different. On Day 2, the substitution elasticity is higher than the non-CPP value by –0.0278 and the difference is statistically significant. The daily elasticity is lower by 0.0214 but not significantly different. Finally, on Day 3, the substitution elasticity is higher by –0.018 but not significantly different from the non-CPP value. The daily elasticity is lower by 0.034 and statistically different.

The key question, of course, is whether or not the differentials in the CPP elasticities are statistically different from each other. This can be determined using the chi-squared test. The results are reported in Table 13. They indicate that the null hypothesis that the differentials are the same cannot be rejected for either the elasticity of substitution or the daily price elasticity at the 5 percent level of significance.

Table 14 presents the impacts for non-CPP days and for the three CPP day-types. To ensure comparability of impacts, the estimates are based on zone-specific central air conditioning saturation estimates, weather conditions for all CPP days during the inner summer period during the two years and CPP day prices.

The benchmark impact is -12.80 percent for the average customer during the peak period. None of the incremental deviations for the three CPP days are significantly different from this estimate, indicating that the impact persists across consecutive days. The benchmark impact is –0.88 percent for the off-peak period. This impact has significant differentials on the three CPP days, and all the differentials are positive, indicating that off-peak energy use is higher on the three CPP days relative to non-CPP days. Finally, the benchmark daily impact is –4.40 percent. The differentials on the three CPP days are all positive but only significant on the third day. Even then, the magnitudes of the differentials are such that the daily impact remains negative on all three CPP days.

5c. Conclusions on Persistence

Looking at the evidence of these two tests, we conclude that while there is some movement in the elasticities across the three day-types, peak-period impacts are largely constant across multiple-day CPP events.

6. Elasticities and Impacts for C&I CPP-V Customers in Tracks A and C

For C&I customers, the SPP tested two tariffs, a two-period TOU rate[10] and a CPP-V rate that is very similar to the CPP-F rate except that the CPP period is variable and an enabling technology was offered or already available to customers. Separate samples were drawn for customers with peak demands below 20 kW (LT customers) and for those with demands between 20 and 200 kW (GT20 customers). All participating and control customers are located in the SCE service territory.

The CPP-V rate was offered to two groups of customers designated as Track A and Track C. The Track A sample was recruited from the general population while the Track C sample was drawn from a pre-existing Smart Thermostat pilot. All Track C customers have central air conditioning and smart thermostats. Most Track A customers have central air conditioning but only 19 out of 58 LT20 customers selected the technology option and 49 out of 83 GT20 customers did so. During the experiment, for Track C customers, both control and treatment customers had their smart thermostats dispatched on CPP days. Thus, responsiveness on CPP days represents price response over and above the amount resulting from the technology. For Track A customers, responsiveness reflects both the impact of behavioral changes as well as technology for those customers who selected the enabling technology.[11] As a result of these differences, comparisons between Track A and Track C customers should be made with carefully.[12]

In 2003, participants were recruited for both Tracks A and C. However, due to recruitment problems and insufficient participants, the Track A treatment sample was not available for analysis in 2003 (control group was installed). Another recruitment phase was conducted in 2004 based on the original sample design. The sampling frame for both treatment and control

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[10] Results for the TOU rate are not yet available.

[11] Importantly, the difference in approach for Tracks A and C does not mean that the impact estimates should be added to get the combined impact of enabling technology and other behavioral changes. The Track A results already reflect this combined impact, whereas the Track C results reflect behavioral changes on Non-CPP days and the incremental impact of behavior over and above technology on CPP days.

[12] For 2005, only Track A will be continued in the SPP, and the treatment and control sample design may be reviewed for improvements in representativeness.

customers for Track A excluded customers that did not have enough load to have an air conditioner and that did not live in a 2-way paging area. The estimating sample for the LT20 segment consists of 47 control and 58 treatment customers. The sample for the GT20 segment has 42 control and 83 treatment customers.

Table 15 contains the elasticity estimates for tracks A and C for 2004. The model specification is very simple. The basic model includes a weather term in both the substitution and daily usage equation. It also includes a price ratio term in the substitution equation but there is no price term in the daily use equation. The price term in the daily use equation was almost always insignificant. Regressions are also performed with square footage and average daily usage (ADU) as explanatory variables that interact with the price term in the substitution equation. In, in the Track A equations, we have included a binary term for "technology" in the substitution equation and interacted it with the price term. As with the residential models, the C&I models are estimated using the difference transformation and the SUR regression estimator. The treatment period began in June 2004 and the estimating database contains data through the end of September. Pretreatment data was not included in the estimation because the pretreatment period was in the winter rate season and the significant change in prices resulting from a simultaneous shift from winter to summer and from pretreatment to treatment rates produced anomalous results.

6a. Commercial and Industrial Results for Track A

- The estimated elasticity of substitution for the LT20 customer segment is –0.045, with a t-statistic of –3.10. The elasticity falls with square footage and rises with average daily use (ADU).[13] Responsiveness is nominally higher for customers with enabling technology but the difference is not statistically significant.

- For the GT20 customer segment, the elasticity of substitution equals –0.0692, with a t-statistic of –8.34. This is higher than the elasticity for the LT20 customers. The GT20 elasticity falls with higher square footage. While there is a nominal reduction in the elasticity as ADU increases, the coefficient on the interaction terms is highly insignificant. Responsiveness is nominally higher for customers with enabling technology but the difference is not statistically significant.

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[13] Square footage information is self-reported from a survey and may be subject to error. The ADU information is from utility files and predates the experiment. We have greater confidence in the accuracy of ADU variable than in the square footage variable. The correlation between square footage and ADU is surprisingly low (e.g., between 0.2 and 0.3).

- Peak period energy use on CPP days for LT20 customers based on the average SPP CPP-V price falls by 6 percent whereas the reduction for GT20 customers equals roughly 9 percent.

6b. Commercial and Industrial Results for Track C

We have estimated elasticities for the year 2003 and 2004 data for Track C. The information reported below pertains to the year 2004. The reader is reminded once again that comparisons between Track A and Track C customers should be made carefully, as Track C customers were equipped with a smart thermostat and had volunteered into a pilot program that pre-dated the SPP.

- The estimated elasticity of substitution for the LT20 customer segment is –0.055, with a t-statistic of –3.88. The elasticity falls with square footage and rises with average daily use (ADU).

- For the GT20 customer segment, the elasticity of substitution equals –0.0632, with a t-statistic of –9.31. This is slightly higher than the elasticity for the LT20 customers. The GT20 elasticity falls with higher square footage and ADU.

- Peak period energy use on CPP days for LT20 customers based on the average SPP CPP-V price falls by 8.6 percent whereas the reduction for GT20 customers equals 10 percent.